S
388.11
H3ao

STATE DOCUMENTS

NOV 26 1974

MONTANA STATE HIGHWAY DEPARTMENT

HIGHWAY PLANNING SURVEY

IN COOPERATION WITH

PUBLIC ROADS ADMINISTRATION

****
****
****

APPLICATION OF THE OREGON SOLVENCY QUOTIENT METHOD TO ESTABLISH PREFERENCE IN THE LOCATION OF THE BROADUS-GILLETTE HIGHWAY IN POWDER RIVER COUNTY

MONTANA STATE LIBRARY
930 East Lyndale Avenue
Helena, Montana 59601

March 1946

Montana State Library
3 0864 1006 2310 0

DATE DUE LIBRARY USE ONLY

MSU OCT 8	'75				
[illegible] '75	[illegible]				

DEMCO 38-301

S/388.11/H3ao
Montana. Dept. of Highways.
Highway Planning Survey.
Application of the Oregon solvency quotient method to establish preference in the location of the Broadus-Gillette highway in Powder River county. 1946.

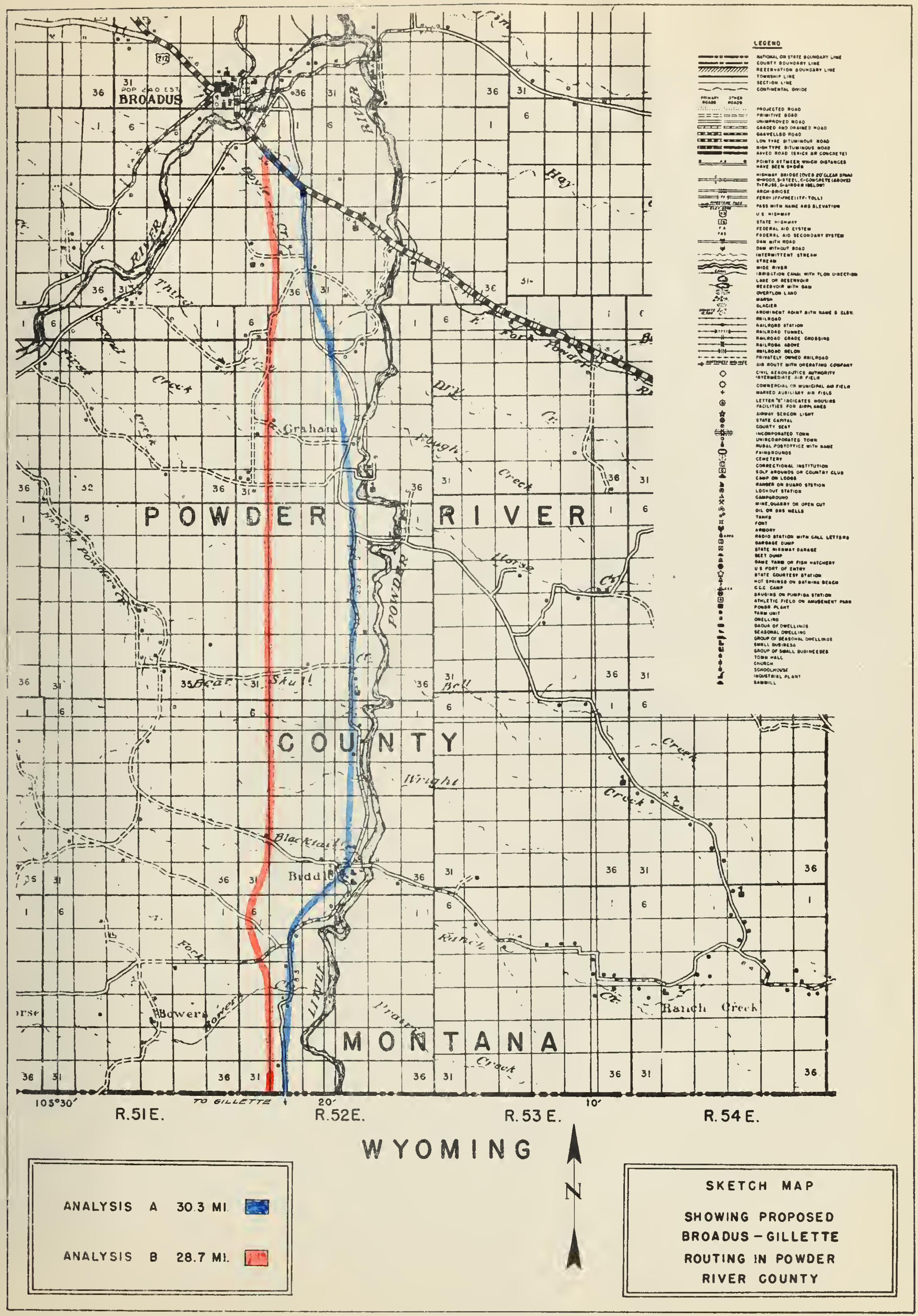
MONTANA STATE LIBRARY
930 East Lyndale Avenue
Helena, Montana 59601

MONTANA STATE HIGHWAY DEPARTMENT
HIGHWAY PLANNING SURVEY
IN COOPERATION WITH
PUBLIC ROADS ADMINISTRATION

****
****
****

APPLICATION OF THE OREGON SOLVENCY QUOTIENT METHOD TO ESTABLISH PREFERENCE IN THE LOCATION OF THE BROADUS-GILLETTE HIGHWAY IN POWDER RIVER COUNTY

March 1946



ANALYSIS A	30.3 MI.	🟦
ANALYSIS B	28.7 MI.	🟥

SKETCH MAP
SHOWING PROPOSED
BROADUS – GILLETTE
ROUTING IN POWDER
RIVER COUNTY

Montana State Highway Department
Traffic and Planning Section
Public Roads Administration
Basic Design Categories
Table No. 1

Standard	Average Daily Traffic	Classification	Max. Grade	Max. Curvature (Degree)	Sight Distance: Non Passing: Horiz. Curvature (Degree)	Sight Distance: Non Passing: Vertical Curvature (Algebraic Difference)	Sight Distance: Non Passing: Feet	Sight Distance: Passing: Feet	Shoulder Width	Width of Road Bed at Grade	Width of Surfacing	Minimum Type of Surfacing	Minimum Base Course
0	0-200	20 M 40	7	14	14	SEE TABLE NO. 2.	280	800	3	24	18	Under 1" Oil	5"
1	201-400	50 M 40	7	14	14		290	800	4	28	20	2" Oil	6"
2	401-800	100 M 40	7	14	14		310	1100	5	32	22	2½" Oil	8"
3	801-1800	200 M 40	7	14	14		320	1100	6	34	22	2½" Oil	8"
4	1801-3500	300 M 40	7	14	14		330	1100	8	38	22	2½" Oil	8"
5	0-200	20 M 60	6	6	6		460	1700	3	26	20	Under 1" Oil	5"
6	201-400	50 M 60	6	6	6		460	1700	4	30	22	2" Oil	6"
7	401-800	100 M 60	6	6	6		470	2100	5	32	22	2½" Oil	8"
8	801-1800	200 M 60	6	6	6		480	2100	6	34	22	2½" Oil	8"
9	1801-3500	300 M 60	6	6	6		500	2100	8	38	22	2½" Oil	8"

Note: Roads having over 3500 vehicles per day require special design.

Digitized by the Internet Archive
in 2012 with funding from
Montana State Library

http://archive.org/details/applicationofore0600mont

TABLE NO. 2

Table giving length of vertical curve required for various Non - passing sight distances

December 18, 1943

Algebraic Difference between grades for convex curvature.	Length of vertical curve for a Non-passing sight distance of: 280 feet	Length of vertical curve for a Non-passing sight distance of: 290 feet	Length of vertical curve for a Non-passing sight distance of: 310 feet	Length of vertical curve for a Non-passing sight distance of: 320 feet	Length of vertical curve for a Non-passing sight distance of: 330 feet	Length of vertical curve for a Non-passing sight distance of: 460 feet	Length of vertical curve for a Non-passing sight distance of: 470 feet	Length of vertical curve for a Non-passing sight distance of: 480 feet	Length of vertical curve for a Non-passing sight distance of: 500 feet
1.00	96	103	117	125	133	258	269	281	305
2.00	191	205	234	250	266	516	539	562	610
3.00	287	308	352	375	398	774	808	843	915
4.00	382	410	469	500	531	1032	1078	1124	1220
5.00	478	513	586	624	664	1290	1347	1405	1524
6.00	574	615	703	749	797	1548	1616	1686	1829
7.00	669	718	820	874	930	1806	1886	1967	2134
8.00	765	820	938	999	1062	2064	2155	2248	2439
9.00	860	923	1055	1124	1195	2322	2425	2529	2744
10.00	956	1026	1172	1249	1328	2581	2694	2810	3049
11.00	1052	1128	1289	1374	1461	2839	2963	3091	3354
12.00	1147	1231	1406	1499	1594	3097	3233	3372	3659
13.00	1243	1333	1524	1623	1726	3355	3502	3653	3963
14.00	1339	1436	1641	1748	1859	3613	3771	3934	4268

MONTANA HIGHWAY PLANNING SURVEY

GUIDES FOR ESTIMATING 1960 TRAFFIC

			Applies to:
1.	100%	= 1941 traffic.	
2.	110% to 125%	= Traffic if route is unimproved at present time but expected to be improved by 1960.	F.A., F.A.S. and Class 1, 2, & 3 Forest Highways. Applies to sparcely settled rural areas. (Add extra traffic generated by logging activities on timber utilization roads or other major industries and traffic induced by these activities).
3.	125% to 150%	= Traffic if route is unimproved at present time but expected to be improved by 1960.	F.A., F.A.S. and Class 1, 2, & 3 Forest Highways. Applies in checkerboard well-settled rural areas or on through-roads. (Add extra traffic generated by logging activities on timber utilization roads or other major industries and traffic induced by these activities).
4.	150% to 200%	= Traffic if route is unimproved at present time but expected to be improved by 1960.	F.A., F.A.S. and Class 1, 2, & 3 Forest Highways. This applies in exceptional cases such as bottlenecks and natural cutoffs. Some cases, of course, might be much more but these special conditions would require special analysis. (Add extra traffic generated by logging activities on timber utilization roads or other major industries and traffic induced by these activities).

Note: Date of expected improvement does not change traffic estimates for 1960.

130% = expected secular growth 1941 to 1960 -- to be applied to all above conditions except traffic generated by logging activities, or other major industries.

Applies to all roads now constructed. (Without any of above increases)

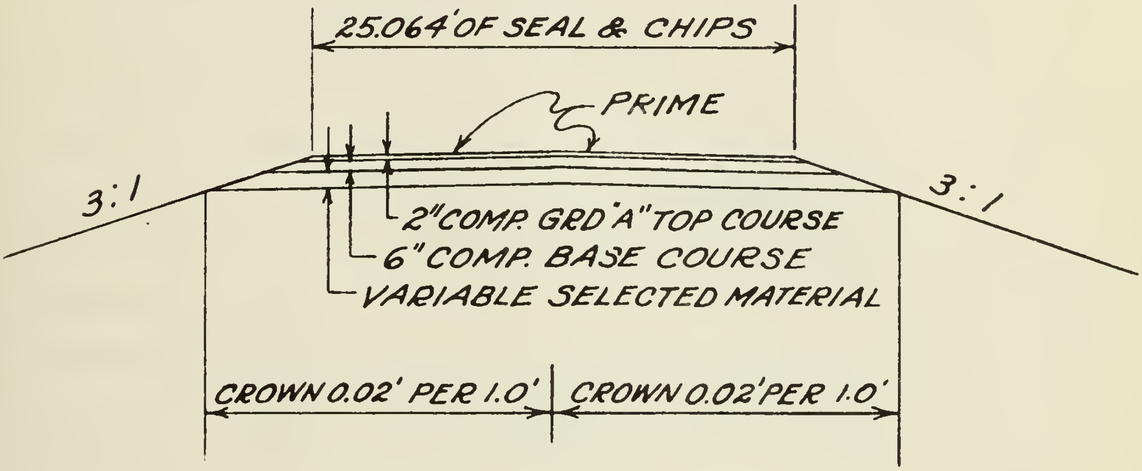
Average summer maximum traffic equals double average ADT except on predominately recreational routes where factor might be as high as 3.

Average summer maximum traffic equals average of several maximum summer days.

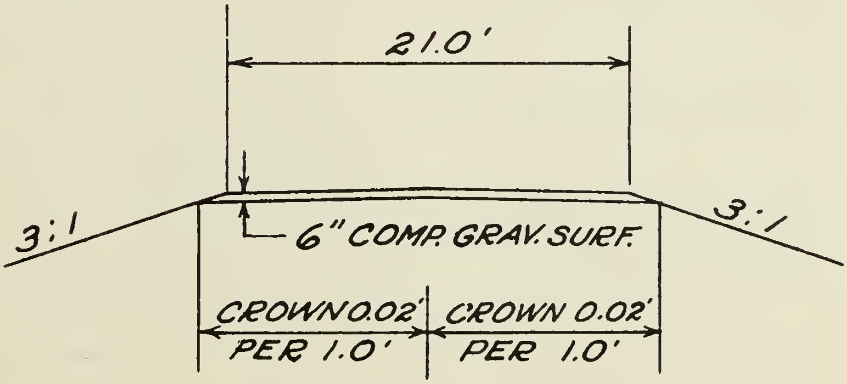
Maximum hour equals 10% of maximum summer ADT. (Usual public traffic), or 15 to 20% on roads used by both the public and by major logging operations or other major industries.

SECONDARY SYSTEM

100 VEHICLES AND LESS THAN 200
AV. 24-HOUR TRAFFIC



UNDER 100 VEHICLES
AV. 24-HOUR TRAFFIC



MONTANA HWY. COMM.
JUNE 1, 1945

TABLE OF CONTENTS

Page

Map. . . . . Frontispiece

Basic Design Categories. . . . . i-ii

Guide For Estimating Traffic iii

Secondary System Standards iv

I. SUMMARY OF FINDINGS. 1-2

Discussion in re solvency quotient -- statement of local service

II. ROUTE DESCRIPTIONS. 2-3

III. TRAFFIC DATA. 3-4

Association of traffic and vocational pursuits -- discussion in re local road use.

IV. ECONOMIC ANALYSES 5-31

A. River Road, 30.3 miles 5-20
1. Annual Cost Calculations 5-9
Standards - construction experience data -- derivation of construction costs per mile -- capitalization of construction costs on an annual basis -- maintenance costs.
2. Average Daily Traffic, 1960. 9-12
Classification of traffic by trip mileage -- Explanatory notes in reference to above.
3. Annual Revenues, 1960 12-13
Source of basic data -- tabulation of estimated income, 1960.
4. Time Element Savings. 14-15
Factors which operate to save time -- statement of time element savings.
5. Mileage Element Savings 15-18
Factors which operate to bring about mileage element savings -- statement of mileage element savings -- explanation and derivation of mathematical formulae
6. Traffic Benefits 18
Allocation of benefits by function.
7. Derivation of Quotients 19-20
Explanation of variables involved in the derivation of the several quotients -- explanation of the significance of the several quotients.

B. Ridge Road, 28.7 miles 20-31
1. Annual Cost Calculations 20-22
2. Average Daily Traffic, 1960 22-24

3. Annual Revenues, 1960 25-26
4. Time Element Savings 27
5. Mileage Element Savings 28
6. Traffic Benefits. 28-29
7. Derivation of Quotients 29-31

V. RECOMMENDATION 31

It is recommended that the Ridge Road location be followed.

APPLICATION OF THE OREGON SOLVENCY QUOTIENT METHOD TO ESTABLISH PREFERENCE IN THE LOCATION OF THE BROADUS-GILLETTE HIGHWAY IN POWDER RIVER COUNTY

I. SUMMARY OF FINDINGS

As shown by the economic analyses which are set forth in Section IV of this report it is not economically feasible to build the Broadus-Gillette highway. A composite solvency quotient of unity, or more, expresses a condition where it is feasible and practicable to construct a highway -- in this study the River routing has a solvency quotient of 0.345 and the Ridge routing, 0.37. Within the purview of the Traffic and Planning Section of the Montana Highway Department, there is no great basis to expect a relatively large volume of traffic, out-of-state, or local at any time in the near or distant future to help the routing to approach solvency. The routing as proposed for improvement touches on and serves a farm-grazing community; it is believed that such construction will not adversely affect the system solvency in south eastern Montana in any great degree. The analyses which follow and on which the solvency quotients are predicated are based on engineering considerations, they do not take into consideration that the existing road system might be blocked with snow in the winter time to necessitate a trip through parts of three states to go from the Little Powder River to Ekalaka in Carter County. Continuing on this theme, engineering considerations do not take into account the value of a highway as a means for seeking or receiving quick medical aid in time of illness or injury, serious or otherwise. Highways furnish a means to better our school system, to improve our governmental functions and to spread our police protection. These are intangible benefits, so to speak, and we have no practical way of laying a dollars and cents value on them.

Suffice it to say, we believe these benefits are sufficient in number and weight to render the Broadus-Gillette Construction on the "profit" side of the ledger in the long run.

Comparing the solvency quotients as set forth in Section IV, we find the Ridge routing to be the better choice from a location standpoint and in respect to total benefit values.

II. ROUTE DESCRIPTIONS

The Broadus-Gillette routing as now used in Powder River County extends from a point on US 212 about 4.0 miles southeast of Broadus through Biddle to the Wyoming - Montana line, total distance, 30.5 miles. The road follows the meandering course of the Little Powder River from the Wyoming line through Biddle to a point near Graham. At this point the road turns west by north and the river east by north. Land service roads bearing in an east-west direction intersect the routing at intervals averaging some 3 to 4 miles -- these intersecting roads serve various farm holdings scattered along small streams tributary to the Little Powder River on the east side of the river. On the west side of the river, the land service roads serve, in addition to the Little Powder River valley residents, those people living in the Powder River drainage area. It is this peculiarity of resident driver habits which furnishes the principal reason for building the new road along the "ridge" location. There are land service roads feeding to the Broadus-Moorhead road but the traffic volumes are almost nil, never exceeding two vehicles per day - the local preference seems to favor those roads leading to the Little Powder River thence north or south as the case may be toward Broadus or Wyoming.

The analyses which follow in Section IV will weigh the solvency of two routes as proposed, one to follow generally the present travelled way (River Road) and the other to follow a course about two miles west of and

parallel to the River Road routing. In the first cited case there will be 19.0 miles of new construction and 9.4 miles of reconstruction using the present road bed; in the case of the Ridge Road there will 28.7 miles of new construction. There will be no special features of construction in either proposition.

III. TRAFFIC DATA

The routings proposed for analyses tap a stock raising region to serve a farm-grazing economy. In so doing, we can expect a relatively low level of traffic volume in the years to come, however, this traffic will be fairly constant and sustained throughout the length of the routes under study. The area feeding to the Little Powder River road is sparsely settled; the road is the only means of transport communication with stock shipping centers in Montana and Wyoming there being no rail facilities in the near vicinity of the region.

It is a possibility that at some time in the future, the road will serve north -- south inter-state traffic between Montana and Wyoming with a corresponding high rate of, traffic increase. If, however, we select the best routing now for low values of farm-grazing traffic, it follows that we will have "braced" ourselves for any notable increase in "through" or inter-state traffic in the future insofar as alignment and highway service controls are concerned. It is to be noted also that in the meantime and pending the time that the road might serve high values of traffic we will have served local farm-to-market traffic in the most advantageous manner and this category of traffic will have availed itself of the several benefits inherent in road and highway construction.

Using the expansion factors cited in the "Traffic Estimation Guide," page iii we can expect to see traffic in the volume and classification set forth on the following page in 1960.

The "Traffic Estimation Guide" allows an increase of 50% in traffic on completion of a through route and 30% in consideration of normal traffic growth. These factors when applied simultaneously have the effect of doubling the existing traffic or 1941 traffic in this case and we believe the results of so expanding traffic are comprehensive enough to allow for future diversion to the routing and for any basic change in the ruling economy of the region which might prompt increased driving by the residents of the Little Powder River Valley. Note that the River Road traffic extends, as an average, over a longer route than that cited in Section II., ROUTE DESCRIPTIONS -- this for the reason that the analyses which follow are set up on a comparative basis with a common terminal on the north and a near-common terminal on the Montana - Wyoming line. Basic data, 1941 traffic volumes, derive from traffic records on hand in the offices of the Montana Highway Department., Traffic and Planning Section.

ESTIMATED AVERAGE DAILY
TRAFFIC FOR 1960

(double the Record of Traffic for 1941)

River Road. 30.3 Miles (if built)		Ridge Road. 28.7 Miles (if built)	
VEHICLE TYPE	ADT	VEHICLE TYPE	ADT
Passenger Cars, local	31	Passenger Cars, local	33
Passenger Cars, foreign	3	Passenger Cars, foreign	3
All Passenger Cars	34	All Passenger Cars	36
Light Trucks	15	Light Trucks	16
Tractor-Trucks & Semi-Trlrs.	1	Tractor-Trucks & Semi-Trlrs.	1
Busses	1	Busses	1
All trucks & Busses	17	All Trucks & Busses	18
All vehicle Types	51	All vehicle types	54

IV. ECONOMIC ANALYSES

A. RIVER ROAD, 30.3 miles.

1. Annual Cost Calculations

It is assumed that the New construction, 28.4 miles, will conform to the standard set forth in the lower half of page iv near the front of this report. It is to be noted that the estimated daily traffic as set forth immediately herebefore would recommend that choice. Under this standard control, costs would be less than those experienced in the building of other roads, primary and secondary, in the vicinity of the Little Powder River Valley, however, basic construction costs are presented herewith as a matter of information.

COMPARATIVE CONSTRUCTION COSTS
EXTENDED TO COST PER MILE
FEDERAL AID PRIMARY-BROADUS SOUTHEAST

							Drainage			
Project	Const. Year	Length	Grading	Clear & Grub.	Gravel Base & Surf.	Oil Surf.	Minor Structures	Major Structures	Engineering &Admin.	Right of Way
262 A	1931	9.358	$36857		$15746	$5000	$6470		$4752	$6381
	1931	0.164						$46422	1666	
262 D	1940	0.238	$1698		$3988	$998	$956		$735	
	1939	0.123						$132538	$4267	
TOTALS		9.883	$38555		$19734	$5998	$7426	$59960	$11420	$6381
AVERAGES:		9.596	$4018		$2056	$625	$774		$572	$665
		9.358	$3939		$1683	$534	$691		$508	$682
OFF-SYSTEM HIGHWAY - BROADUS SOUTHWEST										
317	1934	4161	$14818	$1000	$11663		$8164		$2906	$2727
AVERAGES			$3561	$240	$2803		$1962		$698	$655

It is assumed that the Highway Department will not wish to perpetuate certain features of the present alignment, accordingly, there will be about 19.0 miles of new construction and 9.4 miles of re-shaping the existing road bed. See map, frontispiece for details. Discussion in re unit milege costs is as follows:

New Construction, 19.0 Miles

Grading...$2,800

It is estimated that grading will entail the movement of about 8,000 cubic yards of earth per mile; this volume times $0.35 would render the cost in the neighborhood of $2,800 per mile to take care of grading and any clearing and grubbing which might be encountered.

Gravel Base & Surface..$3,750

In line with gravel costs experienced in the construction of FAP 262 A with due allowance for a probable post-war increase in costs and scarcity of materials in the Little Powder River drainage.

Minor Drainage Structures...$ 850

Assuming less numerous installations than on the off-system construction, WPSO 317.

Major Structures...$ 430

Four bridges, treated wood, at 20 feet, $100 + per lineal foot, costs distributed over 19.0 miles.

Right of Way...$ 600

The route as proposed taps the settled area of the Little Powder River Valley with a probable high real estate value.

Engineering & Administration......................................$ 900

Pre-construction, layout, supervision

Sub-total..................................$9,330

Plus 10% for contingencies..933

Total Estimated Cost per mile.....................................$10,263

Re-shape & Gravel Surface, 9.4 miles

Grading.. $1,850

It is estimated that reshaping will involve the movement of approximately 90 cubic yards of material per station of 100 feet; this amount at say, $0.40 per cubic yard will come to $1,850 per mile.

Gravel Base & Surface...................................... $3,750

See discussion for new construction hereinbefore.

Minor Drainage Structures.................................. $ 425

3 bridges, treated wood, at 20 feet, $100 + per lineal foot, costs distributed over 9.4 miles.

Right of Way... $ 300

Use of the existing right of way will cut down costs for this item.

Engineering and Administration............................. $ 700

Preconstruction, layout, supervision

Sub-total.............. $7,665

+ 10% for contingencies.................................... $ 765

Total Estimated Cost Per Mile.............................. $8,430

Since these analyses involve traffic which will use 1.9 miles of US 212 to arrive at the common northern terminal, this traffic will have to assume its fair share of the cost of that interval of the primary highway. By use of proportions, it is found that this cost is $3516 per mile.

Recapitulating costs for the River Road improvement, 30.3 miles, we have results as follows:

New Construction, 19.0 miles at	$10,263	$194,997
Re-shape & Grav. Surf. 9.4 miles at	$ 8,430	79,242
Primary Construction, 1.9 miles at	$ 3,516	6,680
Total Estimated Construction Cost, 30.3 miles at	$ 9,271	$280,919

In view of the fact that as traffic grows and develops to require a road of higher standard as time goes on we will assign an interest charge of 2½% to the construction costs, the whole cost to be amortized in 20 years. This time period is indicative of the economic service life of the proposed improvement. The effect of so assigning an interest change and capitalizing on the basis of 20 years is to lay up a reserve to allow for increased costs in future higher standard construction. Resolved to an annual capital cost this charge will be $18,007, ($280,919 x 0.0641).

In accord with the practice in other analyses involving projects on the secondary system it is assumed that maintenance charges will approximate $100.00 per mile per year. The maintenance charge for that section of the primary used by this traffic will be $131 per mile per year. The total maintenance cost per year will be $3090, (28.4 x $100 + 1.9 x $131.)

These data are set forth in somewhat lesser detail on the tabulation which follows:

ANNUAL COST CALCULATIONS

Location of project Montana County Powder River
Description of project Broadus-Gillette, River Road
Highway number Highway system FA Secondary
Length Date of analysis February 1946

CAPITAL COSTS

Item	Net Cost	Interest Rate	Amort. Period	Annual Capital Cost
Rights of way, easements, etc.	$ 14,220	2½%	20 yrs.	$ 912
Clearing, grading, etc.	70,590	2½%	20 yrs.	4,525
Pavements and surfacing:	106,500	2½%	20 yrs.	6,827
Type Gravel, 6" Comp.				
Structures:				
Type Major, 140 Ft.	14,186	2½%	20 yrs.	909
Type Minor,	20,145	2½%	20 yrs.	1,291
Engineering & Administration	23,680	2½%	20 yrs.	1,518
+10% for Contingencies	24,918	2½%	20 yrs.	1,597
Unamortized cost old const.......	6,680	2½%	20 yrs.	428
1. Total annual capital cost....................................				$18,007

MAINTENANCE COSTS	Annual Cost
2. Total annual maintenance cost (30.3 x $102)	$ 3,090
TOTAL ANNUAL COSTS (1 ≠ 2)	$21,097

2. Average Daily Traffic, 1960

Those data set forth in Section III in reference to traffic volume apply as an average for the full length of the Broadus-Gillette road in Powder River County. In a situation such as this we know that there are very few "through" trips; that is to say trips which contemplate origin - destination beyond the northern or southern terminals of the routing in Montana and Wyoming. In the tabulation which follows we show travel on the "old" route and on the "new" route, also travel on the approach roads (the intersecting east-west roads cited in Section II) and the total mileage for each trip. The effect of the new construction will be to shorten travel distance for each category of entering traffic at each intersection in a decreasing measure as traffic is listed toward the south. In short, only that traffic which travels through the northern terminal to or from Wyoming will be benefited by the total actual travel distance saving, 2.1 miles in this particular instance. Tabulation is on the following page.

CLASSIFICATION BROADUS-GILLETTE TRAFFIC BY ORIGIN-DESTINATION AND TRAVEL ROUTES

		River Road							
		EXISTING FACILITIES (Miles)				NEW ROUTE (Miles)			
Origin-Destination	ADT	1/ US 212	2/ PTW	3/ Approach Roads	4/ Mileage Each Trip Total	US 212	5/ New Const	Approach Roads	6/ Mileage Each Trip Total
Broadus South (Average) 7/	112	1.9	8.3	2.7	12.9	1.9	8.0	2.7	12.6
Doyle Creek, South	2		8.1	4.8	12.9		7.7	4.8	12.5
Third Cr. Mines - South	8		10.2	5.0	15.2		9.6	5.0	14.6
Mines South, South	4		10.1	5.5	15.6		9.6	5.4	16.0
Graham North, South	2		9.2	7.6	16.8		8.6	7.4	16.0
Graham South, School - So.	2		9.8	8.5	18.3		9.2	8.6	17.8
Horse Creek, South	10		10.0	18.6	28.6		9.6	18.5	28.1
Bear Skull Creek, South	4		7.1	7.0	14.1		6.6	7.0	13.6
Ranch Creek, South	27		4.5	13.1	17.6		3.6	13.2	16.8
Blacktail Creek, South	3		4.6	5.3	9.9		3.9	5.4	9.3
Bowers, South	7		4.7	10.4	15.1		4.5	10.4	14.9
Composite Entry Traffic 8/	69	0.0	6.85	11.0	17.85	0.0	6.2	11.05	17.25
Composite Broadus-Gillette Traffic 9/	181	1.15	7.75	5.85	14.75	1.15	7.30	5.90	14.35

1/ Only that traffic which has origin north of the common northern terminal and bound for points south of US 212 and that traffic which has origin south of US 212 and bound for points north of the common northern terminal will have occasion to use the present, or future, improved primary road for a distance of 1.9 miles.

2/ Being the travel distance on the present existing facility; this mileage plus that described in note 1/ will be the total travel distance along the route as described in Section II.

3/ Being the travel distance necessary, on the average, to bring traffic to the routing as described in Section II.

4/ Being the total mileage, on the average, involved in each trip.

5/ This is the average travel distance over the newly constructed roadway on completion of the improvement.

6/ This is the total mileage for each trip on completion of construction. Note that the approach mileage remains the same, or nearly so, as set forth under note 3/-- the distance saving is effected on the new construction.

7/ This is the principal component of the traffic categories involved in the analysis and involves that small element of traffic which might contemplate a trip through the total length of the routing as described in Section II. Most of this traffic, however, is dispersed through the medium of intersecting roads before any great mileage is run up on the route as described.

8/ This is entry traffic which will be dispersed along the intersecting roads in the region delimited by the northern and southern terminal controls.

9/ These figures are the averages for all traffic which will use the new road, in part, in the course of daily travel in the Little Powder River Valley. If we take the total traffic as set forth in Section III, 51, and multiply this figure by 30.3, the total mileage comprehended in this analysis we arrive

at a daily vehicle mileage total of 1545; this corresponds reasonably close to the daily vehicle mileage figure obtained by multiplying 8.45, (1.15 + 7.30), by 181, resultant 1529 vehicle miles.

3. Annual Revenues, 1960

To arrive at an estimate of annual revenues the traffic data as set forth in Section III were resolved into vehicle - miles and then into ton-miles. These data were then extended on the basis of unit net revenues per ton mile to arrive at an estimate of the total annual income. Unit net revenue rates derive from a general study conducted by this department. Average gross ton figures for each class of vehicle were also ascertained in the course of research work of the Planning Survey. Tabulation is on the following page.

HIGHWAY PROJECT ANALYSIS

Traffic Income 1960

Location of Project Montana Description of project Broadus-Gillette River Road County Powder River

Highway FAS #319 Highway System FA SecondaryLength 30.3 miles Date of analysis February 1946

Traffic Type	Average Traffic			Av. Annual Rd. Use During Life of Project	Unit Net Revenues	Total Annual Net Revenue
	Present	Projected				
	Vehicles ADT	Vehicles Annual	Tons Annual	Ton Mi.	Per Ton Mile	
Passenger Cars-Montana	31	11,366	17,049	516,585	0.002188	$1,130
Passenger Cars-Foreign	3	1,229	1,844	55,873	0.001799	101
Total Passenger cars	34	12,595	18,893	572,458		$1,231
Trucks, light	15	5,427	17,746	537,704	0.003248	1,746
Trucks, medium						
Trucks, heavy						
Trucks, semi-trailer	1	307	4,531	137,289	0.001543	212
Trucks, full-trailer						
Busses	1	205	1,845	55,904	0.001873	105
Total Trucks & Busses	17	5,939	24,122	730,897		$2,063
Total all vehicles	51	18,534	43,015	$1,303,355		$3,294

Average weight of trucks 4.06 tons; All vehicles 2.32 tons. Total Annual Income $3,294
Percentage truck traffic 32.04%. Amortization perios 20 years.

4. Time Element Savings

Time element savings accrue to traffic on completion of construction by virtue of surface and alignment improvements and because of shortened travel distance. Time element savings are tabulated immediately hereinafter. Basic traffic and travel distance data derive from sub-section 2, pages 9-12 of this report. The "New" speed rates are computed from basic data set forth in the Oregon Highway Department Tech., Bulletin No. 7. "Old" speed rates are set with the idea that they will be 8 miles per hour slower than the corresponding "New" rate for each type of vehicle.

Time Element Savings

HIGHWAY PROJECT ANALYSIS

Location of project Montana County Powder River
Description of project Broadus-Gillette, River Road .
Highway number FAS No. 319 Highway System FA Secondary .
Length 30.3 miles Date of analysis February 1946

	Routes	
	New	Old
Annual Traffic Volume		
Private Passenger cars (per year)	44,895	
Trucks, light (per year).........	19,345	
1/ Trucks, heavy (per year)......	1,825	
Private Passenger Cars		
Average speed (miles per hour)...	39.7	35.6
Distance (Miles).................	14.35	14.75
Time (hours per trip)............	0.361	0.414
Time savings per vehicle.........	0.053	
Value of savings ($/vehicle-hour)	$0.60	
Annual traffic volume............	44,895	
Total...................	$ 1,428	
Trucks, Light		
Average speed (miles per hour)...	35.7	31.6
Distance (miles).................	14.35	14.75
Time (hours per trip)............	0.402	0.467
Time savings per vehicle.........	0.065	
Value of savings ($/vehicle-hour)	$0.86	
Annual traffic volume............	19,345	
Total.............	$ 1,081	
Trucks, Heavy		
Average speed (miles per hour)...	28.7	24.6
Distance (miles).................	14.35	14.75
Time (hours per trip)............	0.500	0.600
Time savings per vehicle.........	0.100	
Value of savings ($/vehicle-hour)	$1.47	
Annual traffic volume............	1,825	
Total.............	$ 268	

TOTAL ANNUAL TIME ELEMENT SAVINGS........................$2,777

1/ Tractor-truck semi-trailer combination and busses included with "Trucks, heavy."

5. Mileage Element Savings.

These savings accrue to this traffic as a circumstance of improved riding surface, distance savings and improved alignment. These factors operate to decrease wear and tear on engines and tires; they make a gallon of gas stretch farther. The estimated savings are tabulated hereinafter.

Mileage Element Savings

HIGHWAY PROJECT ANALYSIS

Location of project Montana County Powder River
Description of Project Broadus-Gillette, River Road
Highway number FAS No. 319 Highway system FA Secondary
Length 30.3 miles Date of analysis February 1946

	Routes New	Routes Old
Distance 1/		
Length (miles)	14.35	14.75
Distance savings (miles)	0.40	
Average annual traffic (tons)	153,333	
Annual traffic saving (ton-mi.)	61,333	
Cost ($/ton-mile)	$0.0195	
Total	$1,196	
Surface 2/		
Roadway surface type	0.215	0.26
Saving coefficient	0.045	
Average annual traffic (ton-mi.)	2,261,662	
Saving ($/ton-mile)	0.00088	
Total	$1,990	
Alignment 3/		
Curvature rating	6	1
Points improvement	5	
Saving (point-ton-miles)	11,308,310	
Saving ($/point-ton-mile)	$0.001	
Total	$ 1131	

TOTAL ANNUAL MILEAGE ELEMENT SAVINGS..............$ 4,317

1/ Distance

Average Annual Traffic (tons)

Passenger cars, 123 x 365 x 1.5 = 67,348 tons

Light Trucks, 53 x 365 x 3.27 = 63,258 tons

Trac. Tks. & Semi-trlrs. 3 x 365 x 14.76 = 16,162 tons

Busses, 2 x 365 x 9.00 = 6,570 tons

Total Annual Tonnage = 153,333 tons

Annual Traffic Saving Ton Miles (ton-mile)

Average annual traffic (tons) multiplied by the distance saving.

Cost ($/ton-mile)

Percentage of truck traffic:

$$\frac{53}{181} = 32.04\%$$

Average Gross Weight trucks;

$$\frac{85,990}{58 \times 365} = 4.062 \text{ tons} = 8,124 \text{ lbs.}$$

Operating Cost Computations;

By reference to Fig. 113, Technical Bulletin No. 7, Oregon Highway Dept., it is found that the average operating cost per ton mile of a truck, gross weight 8,124 lbs. is $0.0167. The average operating cost of a passenger car average gross weight 3000 lbs. is $0.0207 per ton-mile. Combining these costs in the proportions manifest we have resultant cost per ton mile as follows:

Pass. Cars, (67.96%) 0.6796 x $0.0207 = $0.0141

Trucks, (32.04%) 0.3204 x $0.0167 = 0.0054

Combined operating cost per ton mile $0.0195

2/ Surface

Surface Type;

In accord with surface improvement coefficients determined by research by the Oregon Highway Department.

NEW

1.15 miles, high type bituminous at 0.03 = 0.035

7.30 miles, gravel surface at 0.19 = 1.387

5.90 miles, unimproved at 0.28 = 1.652

14.35 miles, composite status at 0.215 = 3.074

OLD

1.15 miles, high type bituminous at 0.03 = 0.035

13.60 miles, unimproved at 0.28 = 3.808

14.75 miles, composite status at 0.26 = 3.843

Saving Coefficient;

Subtract the "new" composite status from the "old" status.

Saving ($/ton-mile)

Multiply the operating cost per ton-mile, $0.0195, by the saving coefficient, 0.045. This total times the average annual traffic, ton-miles renders an annual surface saving of $1,990.

3/ Alignment

Curvature rating;

NEW

Assume existing primary, 1.15 miles plus the contemplated new construction, 7.30 miles will take a curvature rating of 10 and the approach roads will have, as now, a curvature rating of zero - the composite curvature rating will then be 6.

OLD

Assume existing primary, 1.15 miles will take a curvature rating of 10 and the balance, 13.60 miles will be, as now, rated at zero - the composite curvature rating will then be 1.

Points Improvement;

Subtract the "old" curvature rating from the "new" curvature rating.

Saving (point-ton miles)

Multiply the "Points improvement" by the "Average annual traffic (ton-mile)".

Saving ($/ point-ton mile).

From rates ascertained in the course of research by the Oregon Highway Department.

6. Traffic Benefits

Allocating benefits to fuel functions and non-fuel functions in accord with the proportions advanced by the Oregon Highway Department we have results as follows:

HIGHWAY PROJECT ANALYSIS

Traffic Benefits

Location of project Montana County Powder River
Description of project Broadus - Gillette, River Road
Highway number FAS No. 319 Highway system FA Secondary
Length 30.3 miles Date of analysis February 1946

Mileage Element Factors

Item		Fuel Function		Non-fuel Function
Distance savings	$1196	38%	454	$ 742
Roadway surface savings	$1990	48%	955	1035
Alignment savings	$1131	50%	566	565
Total Mileage Savings	$4,317	$	1,975	$ 2342

Time Element Factors

Type of Traffic	Annual Value of Time Savings
Passenger Cars	$ 1,428
Trucks, light	1,081
Trucks, heavy	268
Total Time Savings	$ 2,777

Recapitulation of Annual Benefits

Total Fuel Function Benefits		$ 1,975
Non-fuel function benefits	(Mileage element factors $ 2,342	
	(Time element factors 2,777	
Total Non-Fuel Function Benefits		$ 5,119
TOTAL ANNUAL BENEFITS		$ 7,094

7. Derivation of Quotients

With such factual data as we now have prepared we are ready to derive certain quotients as follows indicative of the economic feasibility of building the Valley Road.

HIGHWAY PROJECT ANALYSIS

Location of project Montana County Powder River
Description of project Broadus-Gillette, River Road
Highway number FAS No. 319 Highway System FA Secondary
Length 30.3 miles Date of analysis Feb. 1946

I_{ar}	$= \$\ 3{,}294$	1/ K_1	$= 1.00$
C_a	$= \$\ 21{,}097$	2/ K_2	$= 0.00$
B_n	$= \$\ 5{,}119$	3/ K_3	$= 0.05 / 0.20 = 0.25$
B_f	$= \$\ 1{,}975$	K_2K_3	$= 0.00 \times 0.25 = 0.00$
K_1C_a	$= \$\ 21{,}097$	$1-K_2K_3$	$= 1.00 - 0.00 = 1.00$

4/ $Q_s = I_{ar}/K_1C_a = 3{,}294 / 21{,}097 = 0.155$

5/ $Q_{Bn} = B_n/K_1C_a = 5{,}119 / 21{,}097 = 0.24$

6/ $Q_{Bf} = B_f/K_1C_a = 1.975 / 21{,}097 = 0.095$

7/ $Q'_s = Q_s - K_2K_3Q_{Bf} = 0.155 - 0.00 \times 0.095 = 0.155$

8/ $$\begin{aligned} Q_c = 0.707\ (Q_s + Q_{Bn} + Q_{Bf}\ (1-K_2K_3)) &= 0.707\ (0.155 + 0.24 + 0.095 \times 1.00) \\ &= 0.707\ (0.155 + 0.24 + 0.095) \\ &= 0.707 \times 0.49 \\ &= 0.345 \end{aligned}$$

1/ The constant K, represents the pro rata cost chargeable to the road user.

2/ The constant K_2 represents that portion of the total fuel savings which accrues to traffic which is diverted from other routes in the area - in this case there is no traffic in that category other than that anticipated when we double the existing 1941 traffic volume to arrive at an estimated 1960 traffic volume.

3/ The constant K_3 represents the ratio of fuel tax to the total cost of fuel.

4/ Q_s, the solvency quotient shows that the route when built will "earn" 15.5% of its cost.

5/ and 6/ Q_{Bn} and Q_{Bf} shows that the annual traffic benefits will equal 33.5% of the annual capital costs.

7/ Q'_s, the corrected solvency quotient; in this case there is no diverted traffic as a separate element (see page 4) entering in the analyses, hence Q'_s is equal to and the same as the solvency quotient, Q_s.

8/ Q_c represents the composite solvency quotient when income and benefits in relation to costs are taken into consideration -- it is the true measure of the economic worth of any proposed routing. In this case it is not truly feasible to build the routing as proposed, this because of low traffic volumes, however social and economic necessity require that a road shall be built through the area. In a sense then, the composite solvency quotient furnishes an index or indication of preference in the choice of routes through the Little Powder River Valley, it being conceded that earning capacity and the accumulation of benefits are limited by low values of road use.

B. RIDGE ROAD, 28.7 miles.

1. Annual Cost Calculations

Estimated cost, new construction per mile.

Grading - $3,000

Assuming that grading will average around 10,000 cubic yards of excavation per mile at $0.30 per cubic yard.

Gravel Base & Surface - $3,750

Similar to costs on the River Road.

Minor Drainage Structures - $ 600

Assuming that drainage requirements will be less than that manifest in the valley.

Major Drainage Structures - $ 350

Five treated timber bridges at 20 feet, $100 per lineal foot the costs to be distributed over the total length of the routing.

Right of Way -	$500

The routing traverses a less settled area with a probable resultant lower right-of-way costs than that shown for the River Road, new construction.

Engineering and Administration - - - - - - - - - - - - - -	$800
Sub Total- - - - - - - - - - - - - - - - -	$9,000
Plus 10% for contingencies - - - - - - - - - - - - - - - - -	900
Total estimated cost per mile - - - - - - - - - - -	$9,900

The net cost of new construction will be $284.130, ($9,900 x 28.7). The annual capital cost when interest is applied at 2½% to be paid off in 20 years will be $18,213, ($284,130 x 0.0641).

Add to this an annual maintenance change of $100 per mile, this cost to include charges for administration and overhead plus $50 per mile for the River Road for a distance of 13 miles because the Ridge Road will in effect add about that many miles to the Powder River County road system while allowing abandonment of possibly 15 miles of road. The River Road will continue to serve as a medium of highway transport for those people resident along the road "as is" and for those residents along Horse Creek, Bear Skull Creek, Graham Community, etc., bound for points served by the new Ridge Road.

Cost data are tabulated as follows:

HIGHWAY PROJECT ANALYSIS

Annual Cost
Calculations

Location of Project Montana County Powder River

Description of project Broadus - Gillette, Ridge Road

Highway number FAS No. 319 Highway system FA Secondary

Length 28.7 miles Date of analysis February 1946

CAPITAL COSTS

Item	Net Cost	Interest Rate	Amort. Period	Annual Capital Cost
Rights of way, easements, etc.	$14,350	2½%	20 yrs.	$ 920
Clearing, grading, etc.	86,100	"	"	5,519
Pavements and surfacing:				
Type Gravel, 6" comp.	107,625	"	"	$ 6,899
Structures:				
Type Major, 100 Ft.	10,045	"	"	644
Type Minor,	17,220	"	"	1,104
Engineering & Admin.	22,960	"	"	1,472
+ 10% for contingencies	25,830	"	"	1,655
Unamortized Cost new Const.	284,130	"	"	
1. Total annual capital cost..........................				$18,213

MAINTENANCE COSTS

General maintenance 28.7 miles at $100.00 per mile	$ 2,870
Other items 13.0 miles at $ 50.00 per mile	$ 650
2. Total annual maintenance cost	$ 3,520
TOTAL ANNUAL COSTS 1 + 2)	$21,733

2. Average Daily Traffic, 1960

Construction of the Ridge Road will tend to increase by approximately 2 miles the "approach" mileage for those people resident along the present traveled way and east of the Little Powder River along Ranch Creek and Horse Creek. Conversely, the new road will operate to decrease the "approach" mileage of those people living in the Bear Skull Creek, Third Creek and Graham communities, these people will find their "approach" mileage decreased by about 2½ miles. As a consequence of the new construction we will find also

that there will be a certain amount of induced traffic, equal probably to the "neighborhood" traffic which now obtains along the present county road. The effect of such additive traffic will be to render a total vehicle mileage equal to that previously forecast for the "new" River Road.

This traffic will have traveled off the "old" route in an amount equal to the average mileage ascertained for 181 cars in the first analysis-- this travel distance will be listed as "approach" mileage for 56 vehicles per day. As a consequence of the Ridge Road construction, this traffic will, in the future, travel over 7.1 miles of new construction on each trip and the "new" approach mileage will equal the difference between the new construction mileage and the total mileage of each trip as computed for 181 cars. Traffic data are tabulated hereinafter.

CLASSIFICATION BROADUS-BILLETTE
TRAFFIC BY ORIGIN-DESTINATION AND
TRAVEL ROUTES

RIDGE ROAD

Origin -- Destination	EXISTING FACILITIES, Miles (River Road)					RIDGE ROAD, Miles (New Construction)			
	ADT	US 212	PTS	Approach Roads	Total Mileage Each Trip	ADT	New Constr.	Approach Roads	Total Mileage Each Trip
Broadus South, (Average)	112	1.9	8.3	2.7	12.9	112	8.1	4.3	12.4
Doyle Creek, South	2		8.1	4.8	12.9	2	5.9	6.2	12.1
Third Creek - Mines, South	8		10.2	5.0	15.2	8	6.8	5.9	12.7
Mines South, South	4		10.1	5.5	15.6	4	4.1	11.2	15.3
Graham North, South	2		9.2	7.6	16.8	2	4.8	10.3	15.1
Graham South, School - South	2		9.8	8.5	18.3	2	7.1	10.2	17.3
Horse Creek, South	10		10.0	18.5	28.5	10	2.8	25.6	28.4
Bear Skull Creek, South	4		7.1	7.0	14.1	4	4.8	8.4	13.2
Ranch Creek, South	27		4.5	13.1	17.6	27	1.4	16.2	17.6
Blacktail Creek, South	3		4.6	5.3	9.9	3	4.0	3.0	7.0
Bowers, South	7		4.7	10.4	15.1	7	4.2	9.4	13.6
Composite Entry Traffic	69	0.0	6.85	11.0	17.85	69	3.4	13.7	17.1
Induced Traffic	56	0.0	0.0	14.75	14.75	56	7.1	7.05	14.15
Composite Broadus - Gillette Traffic	237	0.90	5.90	7.95	14.75	237	6.50	7.65	14.15

3. Annual Revenues, 1960

Computed in accord with traffic data set forth in Section III as modified by discussion set forth immediately herebefore. Tabulation follows herewith.

HIGHWAY PROJECT ANALYSIS

Traffic Income

Location of project Montana Description of project Broadus-Gillette, Ridge Road County Powder River
Highway FAS No. 319 Highway System FA Secondary Length 28.7 miles Date of analysis February 1946

Traffic Type	Average Traffic: Present Vehicles ADT	Average Traffic: Projected Vehicles Annual	Average Traffic: Projected Tons Annual	Av. Annual Rd. Use During Life of Project Ton Mi.	Unit Net Revenues Per Ton Mile	Total Annual Net Revenue
Passenger Cars-Montana	33	11,999	17,999	516,571	0.002188	$1,130
Passenger Cars-Foreign	3	1,297	1,945	55,827	0.001799	100
Total Passenger Cars	36	13,296	19,944	572,393		$1,230
Trucks, Light	16	5,729	18,734	537,666	0.003248	$1,746
Trucks, semi-trailer	1	324	4,782	137,243	0.001543	212
Busses	1	216	1,944	55,793	0.001873	105
Total trucks & busses	18	6,269	25,460	730,702		$2,063
Total all vehicles	54	19,565	45,404	1,303,095		$3,293

Average weight of trucks 4.06 tons; All vehicles 2.32 tons. Total Annual Income $3,293

Percentage truck traffic 32.04%.

Amortization period 20 years.

4. Time Element Savings

See discussion for River Road in re theory of development.

TIME ELEMENT SAVINGS

Location of project Montana County Powder River
Description of project Broadus-Gillette, Ridge Road
Highway number FAS No. 319 Highway System FA Secondary
Length 28.7 Miles Date of analysis February 1946

Annual Traffic Volume	Routes New	Old
Private Passenger cars (per year)	58,765	
Trucks, light (per year).........	25,550	
1/ Trucks, heavy (per year).........	2,190	
Totals..............	86,505	

Private Passenger Cars	New	Old
Average speed (miles per hour)...	38.7	35.5
Distance (Miles).................	14.15	14.75
Time (hours per trip)............	0.366	0.415
Time savings per vehicle.........	0.049	
Value of savings ($/vehicle-hour)	$0.60	
Annual traffic volume............	58,765	
Total..............	$1,728	

Trucks, Light	New	Old
Average speed (miles per hour)...	34.7	31.5
Distance (miles).................	14.15	14.75
Time (hours per trip)............	0.408	0.468
Time savings per vehicle.........	0.060	
Value of savings ($/vehicle-hour)	$0.86	
Annual traffic volume............	$25,550	
Total..............	$ 1,318	

Trucks, Heavy	New	Old
Average speed (miles per hour)...	27.7	24.5
Distance (miles).................	14.15	14.75
Time (hours per trip)............	0.511	0.602
Time savings per vehicle.........	0.091	
Value of savings ($/vehicle-hour)	$1.47	
Annual traffic volume............	2,190	
Total..............	$ 293	

TOTAL ANNUAL TIME ELEMENT SAVINGS $ 3,339

1/ Truck and trailer combinations and busses included with "Trucks, heavy".

5. Mileage Element Savings

These benefits are tabulated as follows. See discussion in reference to mileage element savings for the River Road analysis in regard to development of theory.

MILEAGE ELEMENT SAVINGS

Location of project Montana County Powder River
Description of project Broadus-Gillette, Ridge Road
Highway number FAS No. 319 Highway system F.A. Secondary
Length 28.7 miles Date of analysis February 1946

	Routes	
	New	Old
Distance		
Length (miles)...............	14.15	14.15
Distance saving (miles).......	0.60	
Average annual traffic (tons).	197.713	
Annual traffic saving (ton-mil)	118.628	
Cost ($/ton-mile)............	$0.0195	
Total................	$2,313	
Surface		
Roadway surface type..........	0.24	0.265
Saving Coefficient...........	0.025	
Aver. annual traffic (ton-mil)	2,916,267	
Saving ($/ton-mile)..........	0.0049	
Total................	$1,429	
Alignment		
Curvature rating..............	4.6	0.6
Points improvement...........	4.0	
Saving (point-ton-mile).......	11,665,068	
Saving ($/point-ton-mile).....	0.0001	
Total................	$1,167	

TOTAL ANNUAL MILEAGE ELEMENT SAVINGS $ 4,909

6. Traffic Benefits

In which benefits are allocated to fuel functions and non-fuel functions in accord with the procedures advanced by the Oregon Highway Department.

TRAFFIC BENEFITS

Location of project Montana County Powder River
Description of project Broadus-Gillette, Ridge Road
Highway number FAS No. 319 Highway system F.A. Secondary
Length 28.7 miles Date of analysis February 1946

Mileage Element Factors

Item			Fuel Function	Non-fuel Function
Distance savings	$2313	38%	$ 879	$ 1,434
Roadway surface savings	$1429	48%	686	743
Alignment savings	$1167	50%	583	584
Total Mileage Savings	$4.909		$ 2,148	$ 2,761

Time Element Factors

Type of Traffic	Annual Value of Time Savings
Passenger Cars	$1,728
Trucks, light	$1,318
Trucks, heavy	$ 293
Total Time Savings	$3,339

Recapitulation of Annual Benefits

Total Fuel Function Benefits $ 2,148

Non-fuel function (Mileage element factors $ 2,761
benefits (Time element factors $ 3,339

Total Non-fuel Function benefits $ 6,100

TOTAL ANNUAL BENEFITS $ 8,248

7. Derivation of Quotients

Information in re the solvency of the proposed improvement is derived as follows:

HIGHWAY PROJECT ANALYSIS

Location of project Montana County Powder River
Description of project Broadus-Gillette, Ridge Road
Highway number FAS No. 319 Highway system FA Secondary
Length 28.7 Date of analysis February 1946

I_{ar}	= \$ 3,293	K_1	= 1.00
C_a	= \$21,733	1/ K_2	= 112 x 1.9/54 x 28.7 = 0.14
B_n	= \$ 6,100	K_3	= 0.05/0.20 = 0.25
B_f	= \$ 2,148	K_2K_3	= 0.14 x 0.25 = 0.035
K_1C_a	= \$21,733	$1-K_2K_3$	= 1.00 - 0.0395 = 0.965

2/ $Q_s = I_{ar}/K_1C_a = 3{,}293/21{,}733 = 0.15$

3/ $Q_{Bn} = B_n/K_1C_a = 6{,}100/21{,}733 = 0.28$

4/ $Q_{Bf} = B_f/K_1C_a = 2{,}148/21{,}733 = 0.10$

5/ $Q'_s = Q_s - K_2K_3Q_{Bf} = 0.15 - 0.035 \times 0.10 = 0.15 - 0.00 = 0.15$

6/ $$\begin{aligned} Q_c = 0.707\ (Q_s + Q_{Bn} + Q_{Bf}\ (1-K_2K_3)) &= 0.707\ (0.15 + 0.28 + 0.10 \times 0.965) \\ &= 0.707\ (0.15 + 0.28 + 0.10) \\ &= 0.707 \times 0.53 \\ &= 0.37 \end{aligned}$$

1/ The constant K_2 represents that portion of the total fuel savings which accrues to traffic which is diverted to the Ridge Road from that section of US 212 which is now in use by traffic going to or returning from the Little Powder River Valley. In this case it is estimated that this traffic will be 112 vehicles per day in 1960 for a distance of 1.9 miles. The effective diversion in percentage would be as shown on the tabulation.

2/ through 4/ Note that these quotients are similar to those shown for the River Road -- the non-fuel benefits quotient is the only one that shows a significant increase over that tabulated for the River Road analysis.

5/ The corrected solvency quotient indicating the system solvency of the routing under consideration.

6/ The composite quotient of the Ridge Road being somewhat in excess of that shown for the River Road would indicate that this is the route to be built through the Little Powder River Valley.

V. RECOMMENDATION

It is recommended that the Ridge Road location be followed in anticipation of highway construction work in the Little Powder River Valley along the Broadus-Gillette routing.